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The Emerging U.S. System-of-Systems

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Conclusions

The things which give military forces their fighting capability are changing, and these changes point toward a qualitative jump in our ability to use military force effectively.

Probably relating to the way we plan, program and budget for these things, we are more adept at seeing the individual trees than that vast forest of military capability (the system-of-systems) which the individual systems are building for our fighting forces.

The system-of-systems depends ultimately on well orchestrated contributions of all the military services. This assumes a common appreciation of and adherence to what we are building. Most importantly, it requires joint strategic and operational doctrine by which to organize, plan and carry out military operations.

Revolutions Propel U.S. Military Toward Fundamental Change

Three simultaneous revolutions are propelling the U.S. military toward fundamental change. The first is the implosion of the Soviet Union, the end of the Cold War and emergence of the United States as the sole military superpower. We are also experiencing a related revolution--the reallocation of resources from defense to domestic programs, which began almost a decade ago and accelerated with the demise of the Soviet Union. The third is what some call the revolution in military affairs (RMA). In part because of earlier investments, particularly in electronic and computational technologies, the things which give military forces their fighting capability are changing, and these changes point toward a qualitative jump in our ability to use military force effectively. It is the RMA which enables us to take full advantage of the opportunities posed by the first two revolutions, without compromising our national security or position as a world leader.

What kind of changes are emerging as a result of the American RMA? They fall into three general categories, which, for convenience, we may call intelligence, command and control, and precision force:

Intelligence, surveillance, and reconnaissance (ISR), involves sensor and reporting technologies associated with intelligence collection, surveillance, and reconnaissance, as well as the new means by

which we are able to keep track of what our own forces are doing.

Advanced C4I--command, control, communications, computer applications, and intelligence processing--the realm in which we convert the sensor awareness to dominant understanding of a battle space and convert that understanding to missions and assignments designed to alter, control, and dominate that battle space.

Precision force. A broad concept, in which the knowledge and orders generated from the first two areas are translated into action and results.

It is easy to miss the powerful synergy which exists between ISR, advanced C4I and precision force. Look at table 1, a cross section of some of the weapons and systems in use or soon to be available to our fighting men and women. We tend to plan, program and budget for these things as if they were discrete capabilities. We are more adept at seeing the individual trees than that vast forest of military capability which the individual systems, because of their interactions, are building for our fighting forces. Fortunately, when you go to sea or into the field where things are actually happening, you can see early signs of how it all fits together. From this you can envision how future systems in the hands of well-educated and trained officers, soldiers, sailors, marines and airmen portend a qualitatively and quantitatively different military force for the country.

Table 1
Weapons and Systems In or Entering
U.S. Military Inventories

ISR (sensors)	C4I	Precision Force
AWACS	GCCS	SFW
RIVER JOINT	MILSTAR	JSOW
EP-3E	JSIPS	TLAM(BLK III)
JSTARS	DISN	ATACMS/BAT
HASA	JUDI	SLAW
SBIR	C4I FTW	CALCM
TIER 2+	TADIL J	HAVE NAP
TIER 3-	TRAP	AGM-130
TARPS	TACSAT	HARM
MTI	JWICS	AIR HAWK
REMBAS	MIDS	SADARM
MAGIC	SONET	HELLFIRE II
LANTERN		
ISAR	LINK-16	TLAM(BLK IV)

What is happening, driven in part by broad system architectures and joint operational concepts, in part by serendipity, is the creation of a new *system-of-systems*. Merging increasing capacity to gather real-time, all-weather information continuously with increasing capacity to process and make sense of this voluminous data builds the realm of dominant battle space knowledge (DBK). DBK involves everything from automated target recognition to knowledge of an opponent's operational plans and the networks relied on to pursue them.

The growing capacity to infuse DBK into all our forces will be coupled with the real time awareness of their status and the understanding of what they can do with their growing capacity to apply force with speed, accuracy, and precision. This means we will increasingly match the right force to the most promising course of action at both the tactical and operational levels of warfare. Further, we will have an increasing capacity to apply tailored forces faster, with more precise weapons and over greater distances. The advances in ISR will allow us to know the effects of our actions--and understand what those effects mean--with far more fidelity, far earlier than anything we have experienced to date. This will give our forces a great fighting advantage. This battle assessment, in turn, will make subsequent actions more effective. As a result, we truly will be able to operate within the opponent's decision cycle. This new system-of-systems capability, combined with joint doctrine designed to take full advantage of these new fighting capabilities, is at the heart of the RMA. It emphasizes a joint perspective, because the system-of-systems depends ultimately on the well-orchestrated contributions from all the military services. This requires a common appreciation of what we are building and, most importantly, requires common strategic and operational doctrine by which to plan and carry out military operations.

The RMA is inevitable. But the speed at which it comes depends on our willingness to embrace these

changes in our policy, planning and programming decisions. By accelerating the transition, we could actualize the RMA perhaps decades before any other nation. This is important for many reasons; one of the most significant is that it will ensure our ability to protect ourselves while enhancing our ability to shape the international environment, rather than simply react to it.

This, then, is the essence of the argument in favor of accelerating the RMA. It is a bold vision and a controversial one. Visions count, they are what move us forward and provide us the means to deal with an unknown future. However, the professional military should not reify this vision unless it holds up to honest critique. Let us examine the five most thoughtful criticisms that have been raised.

Opponents Fight Back

The conflicts we face will remain competitions among thinking, learning, and adaptive human beings. We need to recognize that any future opponent would diligently and intelligently try to counter capabilities the system-of-systems gives us.

History is replete with examples of how advances in military technology were eventually countered or matched. Yet history also has intriguing examples of real revolutions in military affairs--Guderian's *blitzkrieg*, Ellis's vision of amphibious warfare, and the nuclear revolution come to mind. None of these provided dominance in all areas of military operations, and the edge they provided ultimately eroded. But it was good to have the edge, not only because it paid off in conflict, but also because it gave leverage when implementing foreign policy.

I believe the inherent character of the system-of-systems provides an edge in the competition of conflict. The technology it rests upon emphasizes flexibility and adaptability. It will enable the U.S. military to know more about the flow of conflict than an opponent and to operate well within the decision cycle of that opponent. It will arm American forces with the means of learning faster on a battlefield (traditional or otherwise) and allow them to be more adaptable and flexible than an opponent. In other words, the coming RMA starts from the fundamental assumption shared by its critics: war is a human contest that rewards innovation, learning, adaptability, and flexibility.

Relying on Technology is An Achilles' Heel

Reliance on "information" technologies--the kind of sensors, data processing and communications subsystems that appear in table 1--carries the inherent vulnerability of such technologies to offensive information warfare, or "hacking."

There is, to be sure, great danger in relying on military systems that have exploitable flaws. Indeed, the characteristic that gives any system its potency--that the parts of a system enhance the effectiveness of one another--also makes them susceptible to catastrophic failure if one of their central parts can be corrupted. Yet there are some aspects of the system-of-systems that ought to alleviate, if not refute, these concerns.

First, the people implementing the vision are far from ignorant of the danger of inherent flaws. A great deal of thought, planning, money, and continual effort goes into reducing real or hypothetical vulnerability. We won't wait until someone else finds a vulnerability; we will think and work continually to find and eliminate it first.

Second, the computer and communications technologies on which the system-of-systems are based are

becoming less, not more, susceptible to the various forms of corruption and interference. A race will always exist between those who try to ensure the security of information-based systems and those who seek to overcome their security measures. Yet, the trend favors the defense. In part, this is because of the relative "hardness" of the new generations of communications equipment. Fiber optic cable, for example, has physical characteristics that make it inherently more difficult to "tap" surreptitiously.

Third, there is a robust redundancy to the emerging American system-of-systems. This redundancy works against the possibility of breaking the whole system. It also means that if there are ways of successfully attacking parts of the system, the overall system would not collapse but rather generate "work arounds" or gracefully degrade. In one sense, this is faint praise; we don't want the system-of-systems to degrade at all. In another, it suggests that an opponent would be impotent before he could defend against, counter, or defeat the capabilities we use against him.

Clearly, none of this is cause for complacency; we need to continually bear in mind potential vulnerabilities and work hard to find and end them. Neither can a compelling case be made that the vision is flawed logically or that moving to the system-of-systems carries more practical risk than sticking with the *status quo* and traditional way of doing things.

It Applies Only to the Last War

Some argue that the system-of-systems may work only in a conflict similar to Desert Storm, with relatively open terrain, an inept opponent, and enough time to amass an overwhelming force. Future conflicts may take place in terrain less open, against a motivated force astutely led. Urban areas, jungles, and mountains are as likely to be future battlefields as open deserts. Under these circumstances, it is argued, the system-of-systems is less applicable, and relying on it in place of a more "traditional" force is unnecessarily risky.

However, the system-of-systems applies *across* the full spectrum of conflict. It promises a better, although different, way of doing things. Americans will always seek to use military force with speed, precision, effectiveness and minimal risk to our personnel. The dispositions, movements, and capabilities of an opponent's forces may be easier to discern in open desert than in downtown Mogadishu or triple-canopied jungles. But this is no reason to refrain from trying to discern enemy characteristics. The fact is that the system-of-systems will give us far better capacity to do this, and with greater effectiveness and lower risk than we currently have. Furthermore, it is obvious that it would be highly advantageous to the nation if we found alternatives to the large manpower base and force structure which was the hallmark of our military forces during the Cold War. The system-of-systems and RMA holds out the promise that in the not too distant future the pointed end of the spear may be smaller, far sharper and able to pierce the opponents jugular vein on the first throw.

The System-of-Systems Reduces the Fog and Friction of War

Conflict is chaotic, confusing, and messy. We will never have *perfect* understanding of a battlefield, our systems and weapons will never work flawlessly *all the time*, and the forces we ask to wage war will never do everything correctly *every time*.

The system-of-systems does not offer omniscience or omnipotence. It has demonstrated the ability to reduce the fog and friction of war and promises to do even more so in the future. What counts in war is the relative influence on the opposing side of what some have called the fog and friction of conflict. The side that can reduce the effect of that fog and friction significantly, relative to its opponent, will win.

It's Not Broken; Don't Fix It

There is considerable agreement within the Department of Defense and the services on the central issues: that we ought to continue to develop our capacity to understand the battle spaces in which we may operate, to improve joint operations, and continue to pursue new technologies. The real issue is the rate at which we should move and which technologies and force structures to favor.

The amount of money needed to accelerate the achievement of the vision is not substantial; most of the programs that drive the RMA are already funded. They will reach fruition relatively soon, and not all of them should necessarily be accelerated. Their significance is, after all, a function of their interaction. Accelerating some but not others may give only marginal gains. Some simply cannot come any faster no matter how much money and brainpower we devote to them.

At the center of the debate is whether we should shift resources from some programs and the forces associated with them and give it to others. Making tradeoffs is nothing new. What is new is the rationale used for making them. In the past, we used the perception of the threat (e.g., we developed new capabilities to keep ahead of our peer competitor, the Soviet Union) or the realization that things inside the military were broken and need fixing. The Department went through such a period of introspection after Vietnam.

Now, however, neither of these rationales is particularly relevant: there is no peer competitor and we won the last war. So the Occam's razor has changed. Today's rationales are: 1) maintaining an adequate defense today while building superiority for the 21st century; 2) what the American people will support and the economy can sustain over the long haul.

The system-of-systems is emerging as the result of these rationales. In an increasingly ambiguous and dangerous world, where coalitions will parallel and perhaps replace alliances, and nations will look for U.S. leadership, the smart, flexible, mobile, effective forces the system-of-systems will build makes sense.

Recommendations

The RMA is inevitable. But the speed at which we adapt to it depends on recognition of what is emerging and a willingness to embrace these changes in our policy, planning and programming decisions. By accelerating the transition, we could actualize the RMA perhaps decades before any other nation.

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